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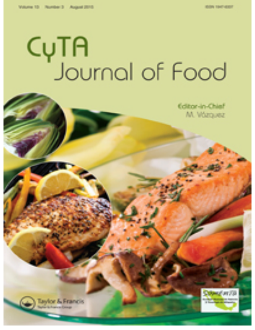

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REVIEW

A review: chemical, microbiological and nutritional characteristics of kefir

Una revisión: Las características químicas, microbiológicas y nutricionales del kéfir

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Kefir, a mildly acidic fermented milk, is produced by the addition of lactic acid bacteria and yeasts to milk. The composition of kefir varies according to factors such as milk type and the microbiological composition of culture types (kefir grain and commercial starter culture). Kefir's distinctive flavour is a blend of lactic acid, ethanol, carbon dioxide and flavouring products, such as acetaldehyde and acetoin. The microorganisms in kefir produce vitamins, degrade protein and hydrolyse lactose, resulting in a highly nutritious and digestible foodstuff. The microbiological composition of kefir has been investigated using a wide range of microbiological and molecular approaches. The microbiological and chemical composition of kefir indicates that it is a very complex probiotic, with *Lactobacillus* species, generally the predominant microorganisms. Kefir is now increasingly being consumed in certain areas of the world, such as southwestern Asia, Europe, North America and Japan.

Keywords: kefir; composition; nutrition; fermented milk product; microbiological properties

El kéfir, una leche fermentada ligeramente agria se produce añadiendo bacterias ácido-lácticas (BAL) y levadura a la leche. La composición del kéfir cambia según los diferentes factores como: el tipo de leche, la composición microbiológica de los gránulos de kéfir y su cultivo. El kéfir posee un sabor distintivo gracias a la combinación de ácidos lácticos, etanol, dióxido de carbono y otros aditivos, como el acetaldehído y la acetoína. Los microorganismos en el kéfir producen vitaminas, crean degradación proteínica y provocan hidrólisis de lactosa. Por ese motivo, el kéfir se ha convertido en un alimento muy nutritivo y digestivo. La composición microbiológica del kéfir ha sido investigada utilizando varios enfoques microbiológicos y moleculares. La composición microbiológica y química del kéfir indica que se trata de un alimento probiótico muy complejo. Los Lactobacillus generalmente son conocidos como microorganismos dominantes en el kéfir. El consumo de kéfir está creciendo en algunas partes del mundo como en Asia, Europa, Norteamérica y Japón.

Palabras clave: kéfir; composición; nutrición; producto lácteo fermentado; propiedades microbiológicas

Introduction

Kefir is a fermented dairy product that originates from the mountains of the Caucasus (Tratnik, Bozanic, Herceg, & Drgalic, 2006). The term is derived from the word *kef*, which means 'pleasant taste' in Turkish (De Oliveria Leite et al., 2013; Guzel-Seydim, Seydim, Greene, & Bodine, 2000). Kefir is also known variously as kefyr, kephir, kefer, kiaphur, knapon, kepi or kippi (Sarkar, 2007). While it has been widely consumed in Russia and central Asia contries such as Kazakhstan, Kyrgyzstan for centuries, it is now increasingly popular in European countries, Japan and the United States due to its nutritional and therapeutic effects (Otles & Cagindi, 2003). Previous studies on kefir have reported antimicrobial, immunological, anti-tumour and hypocholesterolaemic effects, as well as β-galactosidase activity (de Moreno de LeBlanc, Matar, Farnworth, & Perdigon, 2006; Garrote, Abraham, & De Antoni, 2000; Hertzler & Clancy, 2003; Liu et al., 2006).

Kefir is made from kefir grains or mother cultures prepared from kefir grains (see Figure 1). Kefir grains are small, hard, irregularly shaped, yellowish-white granules varying in diameter from 3 to 35 mm, with the appearance of miniature cauliflowers. Figure 2 shows an electron micrograph of kefir grain. These grains contain lactic acid bacteria (LAB) and various yeasts combined with casein and complex sugars in a polysaccharide matrix (Beshkova, Simova, Simov, Frengova, & Spasov, 2002; Guzel-Seydim, Wyffels, Seydim, & Greene, 2005; Otles & Cagindi, 2003). The major polysaccharide is kefiran, comprising equal amounts of glucose and galactose (Rodrigues, Gaudino-Caputo, Tavares-Carvalho, Evangelista, & Schneedorf, 2005; Zajsek, Kolar, & Gorsek, 2011) A good-quality kefir has a foamy, pourable viscosity (Guzel-Seydim et al., 2000). Because the kefir grain is complicated, maintaining its quality in production is problematic, and it also has a short shelf life. The use of microorganisms isolated from kefir grain is now recognized as a promising development (Bolla, Serradell, de Urraza, & De Antoni, 2011) in regard to the standardization of kefir production (Beshkova et al., 2002) and preservation of its desirable properties. It has been demonstrated that the number and variety of microorganisms in kefir manufactured from grain are higher than those in kefir manufactured using the microorganisms isolated from it. Starter cultures containing freeze-dried LAB and kefir yeasts are now being used in kefir production (Farnworth, 2005).

Kefir contains a complex mixture of LAB (lactobacilli, lactococci, leuconostocs, streptococci), yeasts (*Candida* sp., *Kluyveromyces* sp., *Saccharomyces* sp., *Torulopsis* sp., *Zygosaccharomyces* sp.) and sometimes acetic acid bacteria (*Acetobacter* sp.) (de Moreno de LeBlanc et al., 2006; Farnworth, 2005; Guzel-Seydim, Kok-Tas, Greene, & Seydim, 2011; Motaghi et al., 1997; Witthuhn, Schoeman, & Britz, 2004). The symbiotic metabolic activity of a number of bacterial and yeast species creates an unique flavour (Tratnik et al., 2006; Yuksekdag, Beyatli, & Aslim, 2004a).

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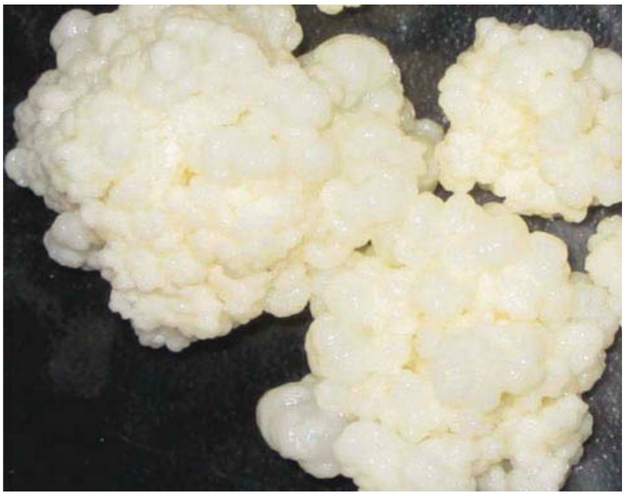

Figure 1. Physical appearance of a typical kefir grain (Ahmed et al., 2013) (reprinted from *Critical Reviews in Food Science and Nutrition*, Z. Ahmed, Y. Wang, A. Ahmad et al., Kefir and health: A contemporary perspective, 53, 422–434. Copyright 2013, with permission from Taylor & Francis).

Figura 1. Aspecto físico de los típicos gránulos de kéfir (Ahmed et al., 2013) (Reimpresión de *Critical Reviews in Food Science and Nutrition*, Z. Ahmed, Y. Wang, A. Ahmad et al., Kefir and health: A contemporary perspective, 53, 422–434, Copyright 2013, con el permiso de Taylor & Francis).

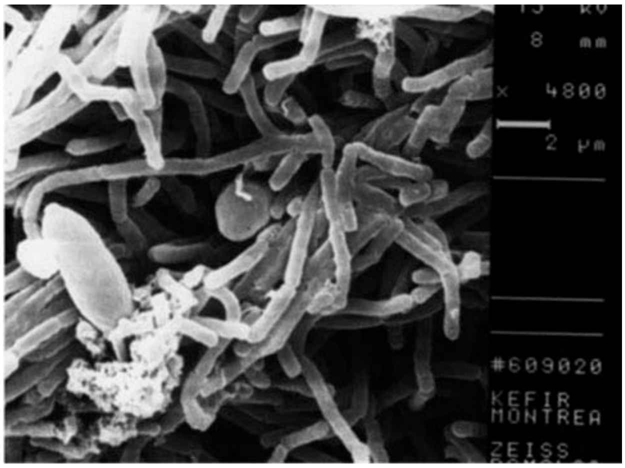

Figure 2. Electron micrograph of a kefir grain (Farnworth, 2005) (reprinted from *Food Science and Technology Bulletin*: Functional Foods, E.R. Farnworth, Kefir – a complex probiotic, 2, 1–17. Copyright 2005, with permission from IFIS).

Figura 2. Micrografía electrónica de barrido de gránulos de kéfir (Farnworth, 2005) (Reimpresión de *Food Science and Technology Bulletin*: Functional Foods, E. R. Farnworth, Kefir - a complex probiotic, 2, 1–17. Copyright 2005, con el permiso de IFIS).

Kefir cultures have also been used as a starter in cheese production (Dimitrellou, Kourkoutas, Banat, Marchant, & Koutinas, 2007) and are suggested as being suitable for baking (Filipcev, Simurina, & Bodroza-Solarov, 2007). Kefir microorganisms can produce single-cell proteins by the aerobic fermentation of cheese whey (Paraskevopoulou et al., 2003). Chen, Kuo, Shiu, and Chen (2011) produced a new kefir candy with health benefits and good flavour. Magalhaes et al. (2011b) determined the chemical and sensory properties of cheese whey-based kefir beverages using grains as a starter culture, and indicated their potential. The present review aims to discuss recent literature relating to kefir and to highlight its microbiological, biochemical and nutritional properties.

Chemical composition

Kefir composition is non-uniform and not well described (Otles & Cagindi, 2003). The type and volume of milk affect its sensory, chemical and textural properties (Altay, Karbancıoglu-Güler, Daskaya-Dikmen, & Heperkan, 2013). In addition, the composition of its grains and cultures and the production process influence its properties (Otles & Cagindi, 2003).

Kefir typically contains 89–90% moisture, 0.2% lipid, 3.0% protein, 6.0% sugar, 0.7% ash and 1.0% each of lactic acid and alcohol (Sarkar, 2007). Kefir has been reported to contain 1.98 g/L of CO_2 and 0.48% alcohol (Beshkova et al., 2002), and the content of carbon dioxide (201.7–277.0 ml/L) positively correlated with the concentration (10–100 g/L) of kefir grains (Garrote, Abraham, & De Antoni, 1998).

Wszolek, Tamime, Muir, and Barclay (2001) studied the properties of kefir made in Scotland and Poland using bovine, caprine and ovine milk with different starter cultures. They found that the chemical composition of kefir ranged from 10.6% to 14.9% for total solids, 2.9–6.4% for crude protein, 3.8–4.7% for carbohydrate and 0.7–1.1% for ash. In another study, Liutkevicius and Sarkinas (2004) reported that kefir grains contain 86.3% moisture, 4.5% protein, 1.2% ash and 0.03% fat. Magalhaes, de Melo Pereira, Campos, Dragone, and Schwan (2011a) found that Brazilian kefir contained 3.91% protein, 2.34% fat and 9.62% dry matter after 24 h of fermentation.

The major products formed during fermentation are lactic acid, CO_2 and alcohol (Otles & Cagindi, 2003). L(+)-lactic acid is the most abundant organic acid (i.e. the highest concentration) after fermentation and is derived from approximately 25% of the original lactose in the starter milk. The amounts of ethanol and CO_2 produced during the fermentation of kefir depend on the production conditions (Farnworth, 2005).

Garcia Fontan, Martinez, Franco, and Carballo (2006) produced kefir from bovine milk using commercial starter cultures. They found that the lactose content declined from 4.92% to 4.02%, the value of L(+)-lactic acid increased from 0.01% to 0.76% and pH fell to 4.24 during the first 24 h of fermentation. After 24 h, lactose was degraded more slowly, the rate of pH reduction decreased and the level of L(+)-lactic acid decreased marginally while that of D(−)-lactic acid had risen (Garcia Fontan et al., 2006). Öner, Karahan, and Çakmakcı (2010) investigated the properties of kefir produced using various milk samples (bovine, ovine and caprine) and culture types (kefir grain and commercial starter culture). They reported that starter culture type, storage period and mammalian species significantly affected changes in pH. In another study, the content of lactic acid ranged from 1.4 to 17.4 mg/mL and that of acetic acid increased from 2.10 to 2.73 mg/mL (Magalhaes et al., 2011a).

Traditional kefir made from caprine milk was found to have a low viscosity and sensory properties unlike those of bovine kefir and contained 0.04–0.3% ethanol (Sarkar, 2008). Tratnik et al. (2006) found that the ethanol content in bovine and caprine kefir enriched with whey protein concentrate was 0.32 and 0.35%, respectively. Lactic acid, acetic acid, pyruvic acid, hippuric acid, propionic acid, butyric acid, diacetyl and acetaldehyde were generated during the fermentation process. These compounds impart the taste and aroma to kefir (Ahmed et al., 2013). Kesenkas et al. (2011) reported that the contents of lactic acid, citric acid, pyruvic acid and acetic acid were 107.80–282.40, 1.79–5.08, 0.17–0.45 and 0.38–0.66 mg/kg, respectively after 28 d of storage.

Diacetyl, acetoin and acetaldehyde, which are aromatic compounds, are present in kefir. Diacetyl is produced by *Streptococcus lactis* subsp. *diacetylactis* and *Leuconostoc* sp. (Otles & Cagindi, 2003). During storage, the concentration of acetaldehyde increases while that of acetoin decreases (Guzel-Seydim, Seydim, & Greene, 2000). Yuksekdag, Beyatli, and Aslim (2004b) demonstrated that all 21 isolates of LAB from various sources of Turkish kefir produced acetaldehyde (0.88–4.40 μg/mL).

Sabir, Beyatli, Cokmus, and Onal-Darilmaz (2010) reported that the lactic acid and exopolysaccharide levels produced by eight strains of *Lactobacillus* sp., *Lactococcus* sp. and *Pediococcus* sp. were 8.1–17.4 and 173–378 mg/L, respectively. Kök-Taş, İlay, and Öker (2014) found the phenolic content of plum- and molasses-enhanced kefir samples to be 2535.8 and 2357.6 mg/mL, respectively.

Microbiological characteristics

The microbial population found in kefir grains has been cited as an example of a symbiotic community; this symbiotic nature has made problematic the identification and study of the constituent microorganisms within kefir grains (Farnworth, 2005).

Numerous microbial species in both kefir and kefir grains were identified using various microbiological and molecular techniques (Diosma, Romanin, Rey-Burusco, Londero, & Garrote, 2014; Gao, Gu, Abdella, Ruan, & He, 2012; Pogačić, Šinko, Zamberlin, & Samaržija, 2013). Dobson, O'Sullivan, Cotter, Ross and Hill (2011) investigated microbial species in kefir grains using high-throughput, sequence-based analysis. Leite et al. (2012) used polymerase chain reaction (PCR)-denaturing gradient gel electrophoresis and pyrosequencing to demonstrate that kefir is produced by a diverse spectrum of microbial species. The microbial population in kefir grain was found to consist primarily of lactobacilli (65–80%) (Wouters, Ayad, Hugenholtz, & Smit, 2002), with lactococci and yeasts comprising the remainder. Population composition can differ by both grain origin and the culture method for the substrate (Wang, Huo, & Liu, 2004). Factors that influence the extent of acidification during kefir production are the size of grain inoculation, agitation and incubation temperature (Irigoyen, Ortigosa, Torre, & Ibanez, 2003).

The predominance of rod-shaped LAB in the outer layer of the kefir grain was reported, along with yeasts at the core, a balance of bacteria and yeasts in the intermediate zone and a progressive change according to distance from the core. Kefir microfloral composition varies according to culture medium and production method (Sarkar, 2008).

Kefir microflora contain many microorganisms, including: *Lactobacillus kefir* (Magalhaes et al., 2011a; Miguel, Cardoso, Lago, & Schwan, 2010); *Lb. acidophilus* (Sabir et al., 2010; Kok-Tas, Ekinci, & Guzel-Seydim, 2012); *Lb. casei* (Magalhaes et al., 2011a; Yuksekdag et al., 2004b); *Lb. helveticus* (Kok-Tas et al., 2012; Yuksekdag et al., 2004b); *Lb. bulgaricus* (Yuksekdag et al. 2004b); *Lb. parakefir* (Garbers, Britz, & Witthuhn, 2004; Garrote, Abraham, & De Antoni, 2001); *Lb. plantarum, Lb. delbrueckii* subsp. *delbrueckii* (Witthuhn, Schoeman, & Britz, 2005); *Lb. rhamnosus, Lb. fructivorans, Lb. hilgardii* (Delfederico et al., 2006); *Lb. paracasei* (Magalhaes et al., 2011a); *Lb. fermentum* (Garbers et al., 2004; Witthuhn et al., 2005); *Lb. crispatus, Lb. gallinarum* (Garbers et al., 2004); *Lb. reuteri, Bifidobacterium bifidum* (Kok-Tas et al., 2012); *Lb. brevis, Leuconostoc mesenteroides* subsp. *cremoris* (Witthuhn et al., 2005); *Streptococcus thermophilus* (Yuksekdag et al., 2004a; Kok-Tas et al., 2012); *Lactococcus lactis, Enterococcus durans* (Yuksekdag et al., 2004a); *Pediococcus acidilactici, P. dextrinicus, P. pentosaceus* (Sabir et al., 2010); *Acetobacter aceti* (Motaghi et al., 1997); *A. lovaniensis* (Magalhaes et al., 2011a); and *A. syzgii* (Miguel et al., 2010).

Witthuhn et al. (2004) reported that LAB and yeast levels present in kefir grains vary widely, ranging from 6.4×10^4 to 8.5×10^8 and 1.5×10^5 to 3.7×10^8 cfu/mL, respectively. Irigoyen, Arana, Castiella, Torre, and Ibanez (2005) reported that in addition to a viable population of 10^8 cfu/mL of lactobacilli and lactococci and 10^5 cfu/mL of yeasts, kefir also contained 10^6 cfu/mL acetic acid bacteria after 24 h of fermentation. The amounts of yeast in kefir vary, with reported values ranging from 10^3 to 10^6 (Farnworth, 2005; Grønnevik, Falstad, & Judith, 2011; Guzel-Seydim et al., 2005; Irigoyen et al., 2005; Simova et al., 2002). In South African household kefir, yeast levels as high as 8 $\log_{10}$ cfu/mL were found (Loretan, Mostert, & Viljeon, 2003).

Miao et al. (2014) isolated 49 LAB species from Tibetan kefir; they found strain FX-6 to be the bacteriocin-producing strain of *Lb. paracasei* subsp. *tolerans*. Nalbantoglu et al. (2014) reported on a metagenomic analysis of the microbial community in kefir grains, finding *Lb. kefiranofaciens* to be the predominant species.

Leite et al. (2012) identified *Lb. kefiranofaciens* and *Lb. kefiri* as the major bacterial populations in all kefir grains. Using culture-independent metagenomic methods, Gao et al. (2013) identified *Shewanella, Acinetobacter, Pelomonas, Dysgonomona*s, *Weissella* and *Pseudomonas* for the first time in Tibetan kefir grains. Dobson et al. (2011) detected *Pseudomonas* sp. and members of the families Enterobacteriaceae and Clostridiaceae in kefir samples.

Yeasts and lactobacilli are mutually dependent and grow in balanced proportions in kefir grains, and symbiosis between yeasts, lactobacilli and streptococci was noted during the production of kefir (Sarkar, 2008).

Yeasts are recognized as playing a key role in the preparation of fermented dairy products, where they provide essential growth nutrients such as amino acids and vitamins, alter pH, secrete ethanol and produce CO_2. The yeasts in kefir are less well studied than bacteria, although the yeasts in grains clearly provide an environment favourable for the growth of kefir bacteria, producing metabolites that contribute to the flavour and mouthfeel (Farnworth, 2005).

Yeasts identified in kefir include *Zygosaccharomyces* sp. (Witthuhn et al., 2004, 2005); *Candida lipolytica, C. holmii* (Witthuhn et al., 2004); *C. inconspicua, C. maris* (Simova et al., 2002); *C. kefyr* (Motaghi et al., 1997; Witthuhn et al., 2004, 2005); *C. lambica, C. krusei, Cryptococcus humicolus* (Witthuhn et al., 2005); *Kluyveromyces marxianus* (Garrote et al., 1998, 2001; Kok-Tas et al., 2012; Loretan et al., 2003; Simova et al., 2002); *Klyveromyces lactis* (Loretan et al., 2003; Magalhaes et al., 2011a); *Saccharomyces cerevisiae* (Garrote, Abraham, & De Antoni, 1997; Loretan et al., 2003; Magalhaes et al., 2011a; Motaghi et al., 1997; Simova et al., 2002; Witthuhn et al., 2004); *S. fragilis, S. lactis* (Motaghi et al., 1997); *S. lipolytic* (Garrote et al., 1997); *Zygosaccharomyces rouxii, Torulaspora delbrus,* *Torulaspora delbrueckii, Debaryomyces hansenii* (Loretan et al., 2003); *Kazachstania aerobia, Lachancea meyersii* (Magalhaes et al., 2011a); and *Geotrichum candidum* (Garrote et al., 1997; Witthuhn et al., 2005).

Grønnevik et al. (2011) found that the LAB count in kefir samples decreased during the first 4 weeks of storage, whereas yeast levels increased throughout the storage period. Diosma et al. (2014) isolated *S. cerevisiae* (15 strains), *S. unisporus* (six strains), *Issatchenkia occidentalis* (four strains) and *K. marxianus* (nine strains) from kefir grains. Uraz, Akkuzu, Özcan, and Sevimay (2012) detected *C. kefyr* and *C. famata* as the most abundant species in kefir samples. Montanuci, Pimentel, Garcia, and Prudencio (2012) reported that yeast, acetic acid bacteria, and leuconostoc counts at the end of storage had either risen or changed only marginally, while those of LAB and *Lactococcus* were decreased or changed only marginally compared with those at the beginning of storage. They found that the acidity of kefir fermented with grains increased during storage, whereas no change in acidity was observed in beverages fermented with a starter culture. Gao et al. (2012) were the first to report the presence of *Pichia kudriavzevii* and *P. guilliermondii* in kefir. Sefidgar, Gharekhani, and Ghasempour (2014) detected *S. cerevisiae* and *Lb. casei* subsp. *pseudo plantarum* using culturing methods and biochemical tests.

Nutritional characteristics

Kefir contains vitamins, minerals and essential amino acids that are beneficial in healing and homeostasis (Otles & Cagindi, 2003). Kefir contains vitamins B_1, B_2, B_5 and C. The vitamin content of kefir is influenced by both type of milk and microbiological flora (Sarkar, 2007). Liutkevicius and Sarkinas (2004) determined that kefir contains vitamins B_5, B_2 and B_1 at approximately 3, <5 and <10 mg/kg, respectively. Kefir also contains vitamins A and K and carotene (Otles & Cagindi, 2003).

Kneifel and Mayer (1991) reported the vitamin profiles of kefir made from milk of different species. They found vitamin concentration enriched by >20% with tiamine (ovine milk), pyridoxine (ovine, caprine, equine) and folic acid (ovine, caprine, bovine).

Kefir contains complete proteins that are partially digested, facilitating digestion by the body (Otles & Cagindi, 2003). The amino acid profile changes during the fermentation of milk, and kefir was found to contain higher levels of threonine, serine, alanine, lysine and ammonia than milk. Kefir also contains other amino acids, such as valine, isoleucine, methionine, lysine, phenylalanine and tryptophan (Otles & Cagindi, 2003; Sarkar, 2007). The essential amino acid contents in kefir are (mg/100 g) valine, 220; isoleucine, 262; methionine, 137; lysine, 376; threonine, 183; phenylalanine, 231; and tryptophan, 70 (Liutkevicius & Sarkinas, 2004). Yuksekdag et al. (2004b) demonstrated the proteolytic activity of lactococci (13/21 strains) isolated from kefir. Kesenkas et al. (2011) reported tyrosine and leucine values of kefir as 0.009–0.016 mg/g and 1.89–9.56 mmol/L, respectively after 28 d of storage.

Tryptophan, one of the most important amino acids in kefir, is of key importance in the nervous system (Kesenkas, Yerlikaya, & Ozer, 2013).

In regard to mineral content, kefir is a good source of calcium and magnesium. Phosphorus, which is the second most abundant mineral in the human body and aids in the utilization of carbohydrates, fats and proteins for cell growth, maintenance and energy, is also abundant in kefir (Otles & Cagindi, 2003). Liutkevicius and Sarkinas (2004) studied the macro- and micro-elements in kefir. They determined that the macro-elements present in kefir grain were: potassium, 1.65%; calcium, 0.86%; phosphorus, 1.45%; and magnesium, 0.30%, while the micro-elements found were: (mg/kg) copper, 7.32; zinc, 92.7; iron, 20.3; manganese, 13.0; cobalt, 0.16; and molybdenum, 0.33 (Liutkevicius & Sarkinas, 2004). Kök-Taş et al. (2014) found that the ash content of kefir samples ranged from 0.55% to 0.66%.

Kefir is a good option for lactose-intolerant individuals, those who cannot digest significant amounts of lactose, which is the predominant sugar in milk. Lactose content is reduced in kefir while that of β-galactosidase is increased as a result of fermentation (Otles & Cagindi, 2003).

It was established that the presence of biogenic amines in kefir samples was due to LAB activity. Putrescine, cadaverine and spermidine were determined in all samples while tyramine was found to be an abundant biogenic amine (Altay et al., 2013).

Other effects

Carasi, Trejo, Pérez, De Antoni, and Serradell (2012) demonstrated that the S-layer proteins from *Lb. kefir* caused a significant decrease in the cytopathic influence of *Clostridium difficile* toxins on eukaryotic cells. Golowczyc, Mobili, Garrote, Abraham, and De Antoni (2007) showed that certain strains of *Lb. kefir* and their S-layer proteins contributed to inhibition of the adhesion and/or invasion of *Salmonella enterica* serovar Enteritidis. The protective action of kefiran on Caco-2 cells challenged by *Bacillus cereus* infection was demonstrated by Medrano, Hamet, Abraham, and Pérez (2009). *B. cereus* infections involve cytopathic effects, such as cell necrosis, F-actin disorganization and microvillus effacement (Medrano, Hamet, Abraham, & Pérez, 2009). The influence of kefiran on the cytopathic activities of *B. cereus* extracellular factors, using various experimental models (cultured human enterocytes and red blood cells), was studied by Medrano, Pérez, and Abraham (2008). Kakisu, Abraham, Farinati, Ibarra, and De Antoni (2013) showed that the cytotoxic activity of type-II Shiga toxin present in *Escherichia coli* O157:H7 strain-69160 supernatants was reduced by cell wall tissue from *Lb. plantarum* CIDCA 83114. They demonstrated that protein molecules in the *Lactobacillus* cell wall are involved in the inhibition of Shiga toxins. Kakisu, Irigoyen, Torre, De Antoni, and Abraham (2011) reported that a combination of *Lb. plantarum* CIDCA 83114 and *K. marxianus* CIDCA 8154 isolated from kefir grains, and *Str. thermophilus* CIDCA 321 isolated from artisanal yogurt starters, was able to inhibit the cytopathic action of Shiga toxins in cell culture. Medrano, Racedo, Rolny, Abraham, and Pérez (2011) demonstrated that orally administrated kefiran can alter the balance of immune cells in a murine model and increase the number of IgA + cells. In another study, the addition of kefir caused a reduction in the level of *Giardia intestinalis* infection 7 days post-infection (Franco et al., 2013). Kakisu, Abraham, Pérez, and De Antoni (2007) observed that kefir grains have an inhibitory effect on the growth and spore germination of *B. cereus*. Carasi et al. (2014) showed that certain strains of *E. durans* isolated from kefir grains exerted an inhibitory influence on various Gram-positive and -negative pathogens.

Conclusion

The microbiota of kefir has especially affected kefir grain from various origins and production methods. Although *Lactobacillus* species represent the major bacterial group involved in kefir, other LAB, yeasts and acetic acid bacteria contribute to its distinctive flavour. In addition to beneficial bacteria and yeasts, kefir contains vitamins, minerals and essential amino acids that aid in homeostasis. Various microorganisms, such as *Shewanella, Acinetobacter, Pelomonas, Dysgonomonas* and *Weissella*, have been detected in kefir. Lactic acid, acetic acid, pyruvic acid, hippuric acid, propionic acid, butyric acid, diacetyl and acetaldehyde formed during kefir fermentation were also determined to contribute to its taste and aroma. The benefits of consuming kefir are numerous, including antibacterial, immunological, anti-tumoural, anti-carcinogenic and hypocholesterolaemic effects and β-galactosidase activity.

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